Surgical outcomes of elderly patients with cervical spondylotic myelopathy: a meta-analysis of studies reporting on 2868 patients

Karthik Madhavan, MD, Lee Onn Chieng, BS, Hanyao Foong, BS, and Michael Y. Wang, MD

Department of Neurological Surgery, University of Miami, Florida

OBJECTIVE Cervical spondylotic myelopathy usually presents in the 5th decade of life or later but can also present earlier in patients with congenital spinal stenosis. As life expectancy continues to increase in the United States, the preconceived reluctance toward operating on the elderly population based on older publications must be rethought. It is a known fact that outcomes in the elderly cannot be as robust as those in the younger population. There are no publications with detailed meta-analyses to determine an acceptable level of outcome in this population. In this review, the authors compare elderly patients older than 75 years to a nonelderly population, and they discuss some of the relevant strategies to minimize complications.

METHODS In accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, the authors performed a PubMed database search to identify English-language literature published between 1995 and 2015. Combinations of the following phrases that describe the age group ("elderly," "non-elderly," "old," "age") and the disease of interest as well as management ("surgical outcome," "surgery," "cervical spondylotic myelopathy," "cervical degenerative myelopathy") were constructed when searching for relevant articles. Two reviewers independently assessed the outcomes, and any disagreement was discussed with the first author until it was resolved. A random-effects model was applied to assess pooled data due to high heterogeneity between studies. The mean difference (MD) and odds ratio were calculated for continuous and dichromatic parameters, respectively.

RESULTS Eighteen studies comprising elderly ($n = 1169$) and nonelderly ($n = 1699$) patients who received surgical treatment for cervical spondylotic myelopathy were included in this meta-analysis. Of these studies, 5 were prospective and 13 were retrospective. Intraoperatively, both groups required a similar amount of operation time ($p = 0.35$). The elderly group had lower Japanese Orthopaedic Association (JOA) scores (MD -1.36 , 95% CI -1.62 to -1.09 ; $p < 0.00001$) to begin with compared with the nonelderly group. The nonelderly group also had a higher postoperative JOA score (MD -1.11 , 95% CI -1.44 to -0.79 ; $p < 0.00001$), therefore demonstrating a higher recovery rate from surgeries (MD -11.98 , 95% CI -16.16 to -7.79 ; $p < 0.00001$). The length of stay (MD 4.14 , 95% CI 3.54 – 4.73 ; $p < 0.00001$) was slightly longer in the elderly group. In terms of radiological outcomes, the elderly group had a smaller postoperative Cobb angle but a greater increase in spinal canal diameter compared with the nonelderly group. The complication rates were not significant.

CONCLUSIONS Cervical myelopathy is a disease of the elderly, and age is an independent factor for recovery from surgery. Postoperative and long-term outcomes have been remarkable in terms of improvement in mobility and independence requiring reduced nursing care. There is definitely a higher potential risk while operating on the elderly population, but no significant difference in the incidence of postoperative complications was noted. Withholding surgery from the elderly population can lead to increased morbidity due to rapid progression of symptoms in addition to deconditioning from lack of mobility and independence. Reduction in operative time under anesthesia, lower blood loss, and perioperative fluid management have been shown to minimize the complication rate. The authors request that neurosurgeons weigh the potential benefit against the risks for every patient before withholding surgery from elderly patients.

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KEY WORDS elderly population; cervical decompression; complication; ERAS; enhanced recovery after surgery; meta-analysis

ABBREVIATIONS JOA = Japanese Orthopaedic Association; MD = mean difference; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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DEGENERATION of the cervical spine is a part of the natural process of aging, with 30% of the population showing degeneration in the 4th decade and 90% by the 7th decade.^{13,14,18,44} Due to variable population demography, symptoms occur at various degrees of stenosis, and radiological scans do not correlate with symptom occurrence.¹⁰ As age progresses, stenosis continually progresses and most patients are symptomatic at an older age.^{6,30,45,46,52} Decompression of the spinal cord for cervical myelopathy has shown excellent results in all age groups of the population, including the group with congenital spinal stenosis.²

On the other hand, there is a significant amount of reluctance among surgeons to perform surgery in the elderly population, given that age is an independent factor for increased morbidity with additional comorbid medical conditions. Life expectancy in the United States has been steadily increasing, with the elderly population expected to reach nearly 45 million by 2050.³⁵ Cervical myelopathy is debilitating, and the patient can soon become deconditioned due to the lack of activities.^{15,49} The goal of this meta-analysis was to pool the data from various publications to study the complication rates of patients older than 75 years and the nonelderly population and also to discuss some of the relevant strategies to limit and overcome complications.

Methods

Study Selection

Combinations of key words that describe age groups (“elderly,” “non-elderly,” “old,” “age”) and disease of interest as well as management (“surgical outcome,” “surgery,” “cervical spondylotic myelopathy,” “cervical degenerative myelopathy”) were used when searching for relevant articles. Two reviewers (L.O.C. and H.F.) independently performed each step of the study selection process. Additional articles were located by cross-referencing articles encountered initially through the PubMed searches. Inclusion criteria required a minimum of 40 patients per study and a report of appropriate outcome data that allowed pooled data analysis. We included case series, retrospective studies, prospective reports, and clinical trials that reported cases of degenerative etiology of cervical myelopathy in our study. Other etiologies such as neoplastic or trauma were not included. Reviews, case reports, cadaveric studies, editorials, and commentaries were excluded.

Data Extraction

After the initial screening using the previously mentioned criteria, the 2 reviewers independently assessed the quality and methodology of each study with the method recommended by the Grading of Recommendations Assessment, Development and Evaluation (GRADE).⁴⁷ The interpretation of an overall strength of “high” means that further research is very unlikely to change our confidence in the estimate of effect as it lies close to that of the true effect. “Moderate” is interpreted as further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate. A grade of “low” means that further research is very likely to have

an important impact on our confidence in the estimate of effect and is likely to change the estimate, whereas “very low” means that any estimate of effect is very uncertain.

The articles were further analyzed based on patient population, country, type of surgical intervention, associated outcomes, length of follow-up, and complications. If there was disagreement regarding the potential relevance of each study, both reviewers discussed the differences with each other until a consensus was reached.

Statistical Analysis

To analyze efficacy of surgical intervention, clinical outcome parameters such as the Japanese Orthopaedic Association (JOA) score and recovery rate (%) were used to calculate mean differences (MDs) in both elderly and nonelderly groups utilizing forest plotting. The JOA score evaluates patients based on functions of the upper extremity (4 points) and lower extremity (4 points); sensory examination results of the upper extremity, lower extremity, and trunk (2 each); and bladder function (3 points). The higher the JOA score, the better the functional status of the patient during the time of assessment. A healthy patient would get a score of 17 points. Some of these studies also attempted to use recovery rate (%) derived from the Hirabayashi formula to further demonstrate efficacy of treatment: $(\text{postoperative JOA score} - \text{preoperative JOA score}) \times 100 / (17 - \text{preoperative JOA score})$.⁶ Radiological outcome parameters of interest such as cervical Cobb angle and spinal canal diameter before and after surgery were also analyzed. The cervical Cobb angle represents the angle between 2 crossed perpendicular lines that are extended parallel to the inferior endplates of C-2 and C-7 on a lateral radiograph of the cervical spine. Spinal canal diameter is measured on an axial MR image of the affected cervical vertebrae. In our analysis, we estimated MD with a 95% confidence interval. Random-effects models were employed due to high heterogeneity of > 70% in most analyses. Odd ratios with 95% confidence intervals were also calculated for dichromatic parameters, which included complication rates. Publication biases were also assessed by constructing a funnel plot and Egger test. A *p* value of < 0.05 was considered statistically significant. All analyses were performed using RevMan version 5.0.

Results

Search Results

With compliance to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, we performed a PubMed database search to identify English-language literature published between 1995 and 2015. The initial search returned 731 studies. After extensive screening, 18 full-text articles that met previously described criteria were included. Of these studies, 5 were prospective and 13 were retrospective in terms of study design. A detailed flowchart of the search procedure is depicted in Fig. 1.

Baseline Characteristic

The characteristics of 18 studies that were included in this meta-analysis are summarized in Table 1. These

FIG. 1. PRISMA flowchart detailing the search strategy for study inclusion.

studies comprised a total of 2868 patients (1169 and 1699 patients were stratified to elderly and nonelderly groups, respectively). Eight studies used 75 years old as the cutoff to define elderly age, while the remaining studies used 65 or 70 years old as the minimum thresholds. Table 2 demonstrates baseline characteristics of each group. The average age of the elderly group was 74.1 ± 5.7 years, while the average age of the nonelderly group was 54.6 ± 10.0 . A posterior approach for surgical decompression was more popular in the nonelderly group (85.3%), whereas an anterior approach was most commonly followed (72.6%) in the elderly group. In the elderly group 47% of the patients were female; 55% of patients were found to have diabetes prior to surgery in the elderly group compared with 45% in the nonelderly group.

Intraoperative Parameters

Six studies comprising 780 elderly patients and 1244 nonelderly patients provided information regarding operative time (Fig. 2). Although not statistically significant, the elderly group required less operation time (MD -6.05 minutes, 95% CI -18.65 to 6.54 , $p = 0.35$). However, there was significant heterogeneity between studies ($I^2 = 90\%$, $p < 0.00001$). Interestingly, the elderly group demonstrated a significant decrease in intraoperative blood loss (MD -12.83 ml, 95% CI -24.54 to -1.11 ; $p = 0.03$) compared with the nonelderly counterpart (Fig. 3).

Clinical and Radiological Outcomes

Fourteen studies, with 1042 elderly patients and 1615 nonelderly patients, used the JOA score to evaluate functional status before and after surgery. The elderly group had lower JOA scores (MD -1.36 , 95% CI -1.62 to -1.09 ; $p < 0.00001$) to begin with (Fig. 4) as compared with the nonelderly group and therefore lower postoperative JOA scores (Fig. 5, MD -1.11 , 95% CI -1.39 to -0.84 ; $p < 0.00001$). Not surprisingly, these elderly patients had lower recovery rates (Fig. 6, MD -11.98% , 95% CI -16.16% to -7.79% ; $p < 0.00001$). They also had slightly longer length of stay in the hospital (Fig. 7, MD 3.93 days, 95% CI 3.05 – 4.82 days; $p < 0.00001$).

Few studies reported radiological parameters, which included cervical Cobb angle and spinal canal diameter before and after surgery for comparison. The pooled average preoperative Cobb angle was $11.5^\circ \pm 10.8^\circ$ in the elderly group compared with $14.2^\circ \pm 9.8^\circ$ in the nonelderly group (Fig. 8). In comparison, the elderly group had a smaller preoperative Cobb angle (MD -3.20° , 95% CI -5.53 to -0.88 ; $p < 0.007$). On the other hand, the pooled average postoperative Cobb angle was $14.3^\circ \pm 10.6^\circ$ in the elderly group compared with $15.8^\circ \pm 11.7^\circ$ in the nonelderly group (Fig. 9). This observed difference was shown to be significant (MD -2.47 , 95% CI -4.27 to -0.68 , $p = 0.007$). Meanwhile, the pooled mean postoperative spinal canal diameter was $19.3 \text{ mm} \pm 2.1 \text{ mm}$ in the elderly group compared with $15.7 \text{ mm} \pm 3.4 \text{ mm}$ in the nonelderly. The elderly group was observed to have greater postoperative spinal canal diameter (Fig. 10, MD 2.32 mm , 95% CI -1.60 to 6.24 mm ; $p < 0.25$).

Complications and Adverse Events

C-5 palsy, CSF leak, pneumonia, and delirium were the most common reported complications after surgery. However, the incidence of C-5 palsy seen in 5 studies was evenly distributed among elderly and nonelderly groups, with no evidence of statistical significance (Fig. 11, OR 1 , 95% CI 0.38 – 2.67 , $p = 1.0$). Although most studies demonstrated a higher incidence of CSF leak in elderly patients as found in 4 studies (Fig. 12), statistical significance was not reached (OR 2.62 , 95% CI 0.67 – 10.27 ; $p = 0.17$). Similarly, the elderly also had a higher but not significant, incidence of pneumonia (Fig. 13, OR 3.94 , 95% CI 0.77 – 20.08 ; $p = 0.10$). Lastly, delirium was the only complication found to be significantly higher in the elderly group (Fig. 14, OR 6.69 , 95% CI 1.1 – 40.6 , $p = 0.04$) with pooled results from 3 studies.

TABLE 1. Baseline characteristics of included studies

Authors & Year	Study Design	Country	No. of Pts	Definition of Elderly	Surgical Technique(s)	Mean Follow-Up in Mos (range)
Nakashima et al., 2015	Prospective	International	479	Elderly ≥ 65 yrs (n = 119); nonelderly <65 yrs (n = 360)	ACDF, discectomy/corpectomy w/ or w/o fusion, laminoplasty, laminectomy w/ or w/o fusion	24
Chen et al., 2015	Retro	China	136	Elderly ≥ 70 yrs (n = 58); nonelderly <70 yrs (n = 78)	ACDF, posterior laminectomy + fixation	39.6 (9–76)
Maeno et al., 2015	Prospective	Japan	100	Group 50s (n = 21); Group 60s (n = 32); Groups 70s (n = 37); Group 80s (n = 10)	Laminoplasty	78
Machino et al., 2015	Prospective	Japan	505	Old-old ≥ 75 yrs (n = 118); young-old 65–74 yrs (n = 186); nonelderly <65 yrs (n = 201)	Laminoplasty	27.2
Son et al., 2014	Retro	Korea	62	Elderly ≥ 65 yrs (n = 28); nonelderly <65 yrs (n = 34)	Laminoplasty	NR
Kanchiku et al., 2014	Retro	Japan	43	Elderly ≥ 75 yrs (n = 43)	ACDF, laminoplasty	25
Yoshida et al., 2013	Prospective	Japan	369	Elderly ≥ 75 yrs (n = 76); nonelderly <75 yrs (n = 293)	Laminoplasty	54
Machino et al., 2012	Prospective	Japan	520	Old-old ≥ 75 yrs (n = 90); young-old 65–74 yrs (n = 143); nonelderly <65 yrs (n = 287)	Laminoplasty	33.3 $\pm$ 15.7
Nagashima et al., 2011	Retro	Japan	113	Group 1, 36–45 yrs (n = 12); Group 2, 46–55 yrs (n = 22); Group 3, 56–65 yrs (n = 31); Group 4, 76–85 yrs (n = 16)	ACDF, laminoplasty, laminectomy	>6 mos
Lu et al., 2008	Retro	China	51	Elderly ≥ 70 yrs (n = 20); nonelderly <69 yrs (n = 31)	Anterior corpectomy+fusion+ fixation	35.3 (24–55)
Ishii et al., 2008	Retro	Japan	56	Elderly 75–86 yrs (n = 20)	Laminoplasty	42 (2.4–103.2)
Holly et al., 2008	Retro	US	70	Elderly 75–85 yrs (n = 36); nonelderly 30–64 yrs (n = 34)	ACDF, laminoplasty, laminectomy+fusion	24 (12–48)
Yamazaki et al., 2003	Retro	Japan	64	Elderly ≥ 65 yrs (n = 35); nonelderly <65 yrs (n = 29)	Laminoplasty	40
Kawaguchi et al., 2003	Retro	Japan	89	Elderly ≥ 70 yrs (n = 20); nonelderly <69 yrs (n = 69)	Laminoplasty	Elderly 39.6 (12–168); nonelderly, 90 (12–204)
Handa et al., 2002	Retro	Japan	61	Elderly ≥ 70 yrs (n = 22); nonelderly <69 yrs (n = 39)	Laminoplasty	
Tanaka et al., 1999	Retro	Japan	47	64–75 yrs (n = 13); 76–85 yrs (n = 34)	Laminoplasty	
Matsuda et al., 1999	Retro	Japan	41	75–81 yrs (n = 17); 20–63 yrs (n = 24)	ACDF, laminoplasty	
Nagata et al., 1996	Retro	Japan	173	Elderly ≥ 65 yrs (n = 50); nonelderly <65 yrs (n = 123)	ACDF, laminoplasty	

ACDF = anterior cervical discectomy and fusion; NR = not reported; Pts = patients; retro = retrospective.

Subgroup Analysis of Patients Older Than 75 Years

Given variability of the operative definition of the elderly population in the included studies, we performed additional subgroup analysis focusing on an elderly population of at least 75 years old to further justify our aforementioned findings. A total of 7 studies used the exact cutoff value. Recovery rate was observed to be significant with mean difference of -11.9 (-16.39 to -7.37 , $p < 0.00001$). The rate of each complication (i.e., C-5 palsy, CSF leak, pneumonia, and delirium) was not significantly different between elderly and nonelderly groups.

Biases

Publication bias was not significant as demonstrated in the funnel plot shown in Fig. 15.

Discussion

In the recent past, there have been several publications on adult deformity revealing successful and acceptable corrections in patients with lower morbidity.^{17,48} Surgeries for correcting cervical myelopathy in general take less operative time and have a narrower field of operation and

TABLE 2. Baseline characteristics of elderly and nonelderly groups

Variable	Elderly (n = 1169)	Nonelderly (n = 1699)
Mean age in yrs	74.1 ± 5.7	54.6 ± 10.0
% male	53.2	54.7
Mean no. of vertebral levels	3.1 ± 1.2	4.2 ± 1.2
% posterior approach for surgical decompression (laminoplasty or laminectomy)	27.4	85.3
% anterior approach (ACDF)	72.6	14.7
% w/ diabetes	55	45

lower blood loss. However, there are several publications with the conclusion that the elderly population does not do well with surgeries for cervical myelopathy. Several significant advances in anesthesia have contributed to lesser morbidity in the elderly population.¹⁶ The aim of our study was to evaluate these papers for complications of surgery using detailed meta-analysis. Several papers reported the JOA score evaluation and we considered it in our scoring system.

Machino et al. in 2012²¹ analyzed 520 patients with cervical myelopathy, among whom 90 patients were older than 75 years. These patients underwent double-door laminoplasty after symptoms for 20 months. It was noted that elderly patients had a lower JOA score to begin with but recovered by 3 points away from the rest of the group. It is important to note that lower JOA scores were not solely reflective of myelopathy but also other comorbid conditions like arthritis, cerebrovascular disease, diabetes, and prostate hypertrophy. Recovery rate calculated using the

Hirabayashi scoring revealed no significant difference in rate of recovery between the groups. In addition, duration of surgery and mean blood loss were lower in the elderly population than in other groups. In 2015, Machino et al.²² performed laminoplasty in 118 patients older than 75 years of age and evaluated them based on JOA score, grip and release test, and 10-step test. Once again, elderly patients had lower JOA scores to begin with. Postoperatively, JOA score, grip and release test, and 10-step test scores were lower than those in the younger population, which can be attributed to a lower number of myelinated fibers in the elderly population. There were no significant differences in postoperative complications, blood loss, and operative time. All patients walked on postoperative Day 1 and on follow-up noted satisfactory recovery from surgery with good ambulation.

Nagashima et al. evaluated the outcomes from French window laminoplasty in 37 patients who were 80 years or older and compared them to a younger population. They noted no significant difference in complications and recovery rate but noted that progress of symptoms to significant deterioration was rather quick in older patients. The 40% recovery rate in the functional status among the > 80-year population is lower than the younger group on JOA scoring but significant enough to improve their life style.³² Yoshida et al. evaluated 76 patients older than 75 years and noted that the expansive laminoplasty improved ambulation in the elderly population and reduced nursing care requirements based on JOA and FIM (functional independence measure) scoring.⁵¹

Radiological Predictors

Currently there is a general consensus among spine surgeons on MRI characteristics of multilevel T2 hyper-

FIG. 2. Forest plot showing the mean difference in operation time (mins) between elderly and nonelderly groups. IV = inverse variance.

FIG. 3. Forest plot showing the mean difference in the volume of blood loss (ml) between elderly and nonelderly groups.

FIG. 4. Forest plot showing the mean difference of preoperative JOA score between elderly and nonelderly groups.

FIG. 5. Forest plot showing the mean difference of postoperative JOA score between elderly and nonelderly groups.

FIG. 6. Forest plot showing the mean difference in recovery rate (%) between the elderly and nonelderly groups. Recovery rate is calculated using the same mentioned formula in each study.

FIG. 7. Forest plot showing the mean difference in length of stay (days) between elderly and nonelderly groups.

FIG. 8. Forest plot showing the mean difference of preoperative Cobb angle (°) between elderly and nonelderly groups.

FIG. 9. Forest plot showing the mean difference of postoperative Cobb angle (°) between elderly and nonelderly groups.

FIG. 10. Forest plot showing the postoperative canal diameter.

FIG. 11. Forest plot showing odds ratio of C-5 palsy in the elderly group. M-H = Mantel-Haenszel.

FIG. 12. Forest plot showing the odds ratio of CSF leak in the elderly group.

FIG. 13. Forest plot showing the odds ratio of pneumonia in the elderly group.

FIG. 14. Forest plot showing the odds ratio of delirium in the elderly group.

intensity, T1 focal hypointensity combined with T2 focal hyperintensity, and spinal cord atrophy, each indicating a need for surgical intervention.³¹ Recently, there has been increasing interest in measuring global spinal sagittal alignment as part of preoperative workup. It is widely believed that with global sagittal misalignment, decompression of the cervical canal alone may not yield a good outcome.^{9,37,41} In certain scenarios, correction of thoracolumbar deformity may improve cervical spine alignment.⁴ However, Lee et al. demonstrated that laminoplasty led to increase in postoperative kyphosis but regional cervical sagittal balance did not correlate with outcome.¹⁹ On the other hand, Sakai et al. showed that a cutoff age of 75 years and 42 mm of the center gravity of the head to C-7 sagittal vertical axis (distance between anterior margin of external auditory canal plumb line and posterior-cranial corner of the C-7 vertebral body) were associated with postoperative kyphotic deformity.³⁸ Smith et al. noted that the sagittal imbalance correlated directly with myelopathy symptoms

and progression.⁴⁰ Some evidence has suggested the addition of fusion if range of motion is more than 20° as it has correlated with poorer outcomes due to postoperative kyphosis development in a group of elderly patients ($n = 45$) 60–86 years of age.²⁴ It is apparent that existing sagittal plane deformity or regional cervical kyphosis leads to suboptimal outcome. Therefore, we suggest entire 36-inch spine images before offering surgery to elderly patients to prevent poorer outcome.

Morbidity Following Surgery in the Elderly Group

As mentioned above, postoperative delirium was the only complication found to be significant in our analysis. Shi et al.,³⁹ in their meta-analysis of patients who developed delirium following spine surgery, demonstrated age as the biggest risk factor (> 70 years old, OR 15.9, $p < 0.001$). Other significant factors included female sex, number of medications, and low preoperative hematocrit and albumin

FIG. 15. Funnel plot showing publication bias was not significant.

levels. Nonetheless, the exact underlying pathophysiology of postoperative delirium among elderly patients remains unknown.

Value of Surgical Treatment in Elderly: Is There a Significant Gain?

In our analysis, we demonstrated lower recovery rate in the elderly patients. These patients do not seem to translate neurological recovery into functional improvements as well like their younger counterparts. Despite this observation, Nakashima et al.³⁴ was the only group that looked into patient-reported outcome (Neck Disability Index and SF-36) and revealed no difference between the elderly and nonelderly cohorts. This implied that elderly patients can still make significant gains in their quality of life without the need to achieve as much improvement as their younger counterparts. Solely assessing the neurological improvement is insufficient to appreciate clinical outcome in the elderly population as sense of quality of life likely differs between age groups. Hence patients' experience in its totality should be prioritized in today's value-driven health care system.

In our institution we have been working closely with the anesthesiology team to limit perioperative fluid administration in the elderly.^{27–29} We are in the process of implementing the “enhanced recovery after surgery” (ERAS) a protocol which begins from the preoperative conditioning until the patient is discharged.^{26,36} In addition, narcotic use is being replaced with administration of long acting bupivacaine. The data collection is in progress, and, to date, results still appear to be promising. We expect to publish these data in the near future.

Limitations of the Study

There exist numerous limitations in our study. As in many retrospective analyses, the limitations of the study include the lack of randomization. The outcomes were not blinded to investigators. There are different types of laminoplasty that were undertaken and some were combined with anterior cervical discectomy and fusion. For instance, in our study, we demonstrated lower intraoperative blood loss in the elderly. This observation may be due to the fact that the patients received smaller or less complex surgeries. Only one study, by Nakashima et al.,³⁴ used an adjustment model to control for potential confounders such as baseline severity score, smoking status, comorbidity score, diabetes, cardiovascular disease, and rheumatological disease. However, age remained the significant predictor for neurological recovery in the same study. The remaining included studies did not extend their investigation beyond univariate analysis. While it was a huge challenge to control these confounders, we provided a table showing baseline characteristics between younger and older patients. Nonetheless, we also performed subgroup analysis of the population older than 75 years in an attempt to minimize variability. In addition, there will always be a better outcome with surgeons who have performed several cervical decompression surgeries.

Conclusions

Cervical myelopathy is a morbid condition, and the elderly population is known to deteriorate rapidly with a lack of mobility and increased risk of being bedridden. We performed a meta-analysis on the outcomes of 2868 pa-

tients and found that elderly patients started out with lower JOA scores and hence did not recover like their younger counterparts in the study. However, recovery reduced their dependence, as these patients required reduced nursing care. Furthermore, several publications have shown that recovery and complication rates are not significantly different in incidence from the younger population. We also suggest assessment of the entire spinal column for other deformities common in the elderly and that correction of these deformities can improve cervical alignment. Furthermore, coexisting deformities of the spine have led to limited recovery. By reducing operative time, blood loss, and perioperative fluid management, we can reduce complications and improve recovery rate.³

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Disclosures

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Conception and design: Madhavan, Wang. Acquisition of data: Chieng, Foong. Analysis and interpretation of data: Madhavan, Chieng, Foong. Drafting the article: Madhavan, Chieng. Critically revising the article: Madhavan, Wang. Approved the final version of the manuscript on behalf of all authors: Madhavan. Statistical analysis: Chieng. Administrative/technical/material support: Wang. Study supervision: Wang.

Correspondence

Karthik Madhavan, Department of Neurological Surgery, University of Miami Miller School of Medicine, Lois Pope LIFE Center, 2nd FL., 1095 NW 14th Terrace, Miami, FL 33136. email: drkarthik19@gmail.com.